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ART. II. — EXACT SCIENCE IN AMERICA.

HOWEVER strong may be the faith of Americans in the future greatness of their country, their opinion of its present intellectual development is modest in the extreme. To the average intelligent citizen, the idea of this country producing such a mathematician as Le Verrier, or such a physicist as Tyndall, is simply incredible. All he has known of the scientific world leads him to believe that such men are necessarily of transatlantic origin. Our citizen has also a theory which explains the deficiency to his entire satisfaction, and, indeed, reconciles him to it, namely, that the activities and energies of this country are all directed toward material development, and that the atmosphere produced by this development is unfavorable to the production of the highest intellectual qualities. He therefore waits for the intellectual development of his country with the same philosophic patience with which he looks forward to the day when her infant manufactures will no longer need protection against European labor and capital.

Now, while, as we shall presently see, our citizen is quite right in the general belief that we are a generation behind the age in nearly every branch of exact science, he is entirely wrong in his view of the form which that state of backwardness assumes, and of the causes which have led to it. As a matter of fact, this country does produce abler mathematicians than Le Verrier, and abler physicists than Tyndall; only he has never heard of them, and would not believe in them if, by any accident, he were to hear. Scientific investigators have to be born; and there is no sufficient evidence that they are born in any smaller numbers in proportion to population here than in Europe. What little real science we have, hidden in out-of-the-way corners, is fully equal to the average of European science. A comparison of census returns would probably show that the proportion of men engaged in intellectual and professional pursuits is nearly as great in this as in the average of other civilized countries. Nor are the facilities for prosecuting science here so much less than in Europe as to excuse our backward-

ness. And yet, that the amount of published investigation, in nearly every branch of exact science, is small in an extraordinary degree, can be seen by a comparison of our contributions to science with those of Europe.

In the present survey we confine ourselves to the exact or physical sciences in contradistinction to biological science, and to pure in contradistinction to applied science. It is quite true that we thus bring to light our weakest points, and that, if we extended our survey into other fields, we could find things more pleasing to our national pride than those we expect to find in the field we have chosen. There is no objection to our knowing where we are weak, because then we may know where our efforts must be applied in order that we may become strong. The division between our strong and our weak points is not, however, by any means that between the exact and the biological sciences, but that which separates the highest purely intellectual efforts from every other field of activity. Were we to look at the philosophic side of natural history, as exemplified by the works of such men as Darwin and Huxley, we might find here nearly as great a dearth of activity as in the exact sciences. On the other hand, were we concerned with the application of even the exact sciences to the arts of life, we should find our country in the front ranks of progress. We omit the consideration of these, because our object is, not to treat of the efforts to which we are impelled by our daily physical wants, but those to which we are impelled by the purely intellectual wants of our nature.

In such a survey as that proposed, we naturally begin with mathematics, not merely as standing at the head of the exact sciences, but as the key with which the portals of every science must be opened before it can properly be called exact. It is probable that few, even among intelligent men, understand that hardly any physical science can attain its highest development until its propositions are expressed in mathematical language, and its deductions are effected by algebraic formulæ. Now, when we seek for published mathematical investigation in this country, we find hardly anything but an utter blank. Of mathematical journals designed for original investigations, such as we find in nearly every country in Europe, we have

none and never have had any. There have been a number of short-lived attempts to establish mathematical periodicals suited to the state of the science here, some of them worthy of all praise; but the necessity of adapting their contents to the capacity of their readers prevented them from containing anything of importance in the way of original investigation. Since the discontinuance of the "Mathematical Monthly," in 1861, we have not had, until the present year, even one of these popular mathematical journals. Quite lately an indication that some cultivators or students of mathematics must still exist has been given by the appearance from Iowa of several numbers of "The Analyst."

With no wish to disparage the praiseworthy effort to start a mathematical journal of any kind, it must be confessed that this publication is of the same kind with its predecessors, being principally devoted to the solution of problems, and to discussions too elementary to have much interest for mathematicians. The only place in which we can search for anything in the shape of original contributions to mathematics is in the transactions of our learned societies; and here we find since the Declaration of Independence a score or two of papers professedly of this character, but it is not likely that more than one or two of them contain anything worthy of quotation or remark. The whole of them together would not amount to so much as the mathematical journals of Europe publish in a month. Of late years, even these solitary contributions appear to have ceased, and the German *Jahrbuch der Mathematik* has not, since its first appearance, in 1868, found a mathematical paper published in America, though it gives a list of ninety-six European serials containing such papers.*

The prospect of mathematics here is about as discouraging as the retrospect. To become a mathematician it is necessary to study the writings of the great mathematicians, and these are entirely inaccessible, except by private purchase, outside of New York, the Eastern States, and the city of Baltimore. The

* So far as we are aware, the last considerable contribution to mathematical science published in this country is Professor Peirce's paper on the Rings of Saturn, printed by the National Academy of Sciences, in 1865, unless we should except a couple of short notes by Mr. Ferrel in the Smithsonian Contributions.

writer has made diligent but vain inquiry to find in a single public library of the second city on the continent any of the writings of the great mathematicians of the present century. The National Library at Washington is almost equally deficient. Its collection of such books as a mathematical student would wish to refer to is poorer than that of many a private individual. The probability that there would be no one to consult them affords a reason for not purchasing them. If the reader will visit the Royal Library at Berlin, he will find among the dictionaries and other works kept for constant reference in the public reading-room a set of Crelle's *Mathematical Journal*, the volumes of which are among the best thumbed there; and if, as he looks at them, he will reflect that our National Library does not possess the volumes at all, he will need no further illustration of the relative state of mathematical science in the two countries.

When we pass to the physical sciences, the prospect is a little more encouraging. We find the names of Franklin and Henry in the history of electrical science. We have two or three active workers in the line of experimental physics who deserve to be ranked among the intellectual ornaments of our country. But the smallness of the sum total of their published productions may be inferred from the circumstance that there is but a single journal to publish their researches, and that this journal covers the whole range of biological and physical science. Here, as in every other science, we find our deficiency to increase just in proportion as the science becomes exact. Many branches of physics have attained, and nearly all the remaining branches are rapidly attaining, the mathematical stage of development. As they enter this stage we find our American cultivators all dropping off.

In astronomy we can make as good, perhaps a better, showing than in physics. In exact astronomy we have the names of Bowditch and Peirce. We have observatories quite comparable with those of Europe, well supplied with astronomers fully equal in ability to the ablest of Europe. In no country is the astronomical work that is done better done. Yet we do not find our astronomers engaging in investigations of the utmost delicacy; and the first determination of the parallax of a fixed

star by an American astronomer has yet to appear. Like all other scientific investigators, our astronomers are crippled by the want of a medium of prompt and certain publication. Measured by the quantity of matter published, we fall far behind Germany, France, and England.

The general deficiency alluded to will be brought out with statistical exactness by an enumeration of our scientific journals and transactions. We have but a solitary scientific journal of the first class. This was established half a century since by Professors Silliman and Dana, during which time it has honorably represented American science. It served the purposes of all the sciences when it was founded, and it serves them still. The only other medium of publication of original investigations in exact science is to be looked for in the proceedings and transactions of our learned societies. Of these, the former generally contain only short notices of papers, while the latter appear at such long intervals that they afford only a very tardy means of publication. Our two most active societies have been the Philosophical Society of Philadelphia and the American Academy of Arts and Sciences, each of which has brought out about a dozen volumes of transactions since the beginning of the century. Excluding societies whose publications are purely biological, we are not aware that half a dozen other volumes of transactions have appeared within the interval alluded to. Add the eighteen volumes published by the Smithsonian Institution, itself founded by a foreigner, and we shall have a total of between forty-five and fifty volumes in three fourths of a century. This total combined product of the Smithsonian Institution and all the scientific societies of the country is about equal to what either the Royal Society or the French Academy of Sciences publishes in one third the time.

The great mass of scientific papers in Europe do not, however, appear in transactions, but in scientific journals. Here we stand at a much more striking disadvantage. Against a hundred and fifty or two hundred pages annually on astronomy and physics in Silliman's Journal, Germany can show us two journals of pure mathematics,* publishing together three

* Borchardt's (Crelle) *Journal für die reine und angewandte Mathematik* and *Mathematische Annalen*, herausgegeben von Carl Neumann.

or four large volumes of matter every year, two more of mathematics and physics,* one of astronomy,† and one of physics and chemistry.‡ Altogether these journals issue ten or eleven volumes annually, half of them quarto and half octavo.

The comparison with England is more difficult, because, for reasons which we shall hereafter explain, the great mass of English research appears in the journals, proceedings, and transactions of societies. Were we to compare these, bulk for bulk, with our own publications, the comparison might be as much to our disadvantage as in the case of Germany. But this comparison would not be fair, for the reason that a great deal of the matter published by these societies is of a semi-popular character, hardly entitled to be classed among original contributions to science. Making allowance for this, it is probable that, instead of finding in England, as we do in Germany, thirty or forty times as much publication of original research in exact science as in America, we should find only five or ten times as much. A comparison with France would probably be more to our disadvantage than that with England, as the *Comptes Rendus* of the French Academy alone contain ten times more matter pertaining to exact science than Silliman's Journal does.

It may be asked whether this comparison of gross quantities of scientific publication affords a fair and accurate criterion of the scientific status of the several countries, and whether there is really thirty or forty times as much scientific investigation in Germany as here. We reply that, in order to make the comparison entirely fair, there are two circumstances to be allowed for. One is, that much of our work is published in a very condensed form, and therefore does not occupy so much space as corresponding work might where the means of publication are more ample. But results lose so much in value by condensation, that the amount of allowance to be made for this circumstance is not very large. The other circumstance is that a great deal of our work is published in foreign journals. Our

* Grunert's *Archiv* and Schlomilch's *Zeitschrift*.

† The *Astronomische Nachrichten*.

‡ Poggendorf's *Annalen der Physik und Chemie*.

observatories, for instance, have no medium of publication except the *Astronomische Nachrichten*.

Making every possible allowance, and viewing the facts from every standpoint, we shall be able to make only the most begrudgingly and humiliating showing. What is yet worse, we cannot claim to be improving our relative position, but are rather falling back, scientific activity increasing more rapidly in Europe than here. If we find improvement in one place or one direction, we find decadence in another to counterbalance it. In what was, in times past, one of our great scientific centres we now find, so far as the world can learn, not a solitary mathematician, astronomer, or physicist.

We have here a picture presented to our view which should command the serious attention of all who desire the intellectual progress of this country. Why, with our numerous educational institutions, and our great crowd of professors, should our contributions to the exact sciences be so nearly zero? If the popular idea of the cause of this state of things were correct, we should have neither literature, art, nor liberal education. However low an opinion we may form of our education, literature, and art, we cannot assign them to the contemptible position alongside the education, literature, and art of the world which our science holds in the science of the world. We conceive that the true cause is not to be found in any lack of ability among our scientific men, nor in anything in our intellectual atmosphere which is positively unfavorable to the prosecution of science. The lack of a proper educational system does indeed prevent the training of a proper number of investigators in the higher branches; but this does not account for the comparative inactivity of our admittedly first-class men. The real proximate cause is found in the lack of any sufficient incentive to the activity which characterizes the scientific men of other nations, and of any sufficient inducement to make young men of the highest talents engage in scientific pursuits. The reason that so much more scientific investigating is done in Germany than in this country, is simply that the inducements to do it are there so much more powerful. A glance at two features of the scientific development of the present day will enable us more clearly to appreciate the state of things in the various

countries referred to. The spirit of modern science and its law of development are largely expressed in two antithetical and, to the superficial glance, inconsistent propositions.

The first proposition is, that the methods and objects of our scientific investigation are distinguished by their purely practical character, using the word "practical" in its best sense. Indeed, the most marked characteristic of the science of the present day, and that which distinguishes it both from the science of the ancients and from the speculations of untrained minds on scientific subjects at the present time, is its entire rejection of all speculation on propositions which do not admit of being brought to the test of experience. Let us take an astronomical prediction as an example; on July 29, 1878, at half past three in the afternoon, the dark shadow of the moon will pass over the city of Denver in the Territory of Colorado; and during three minutes the gloom of night will take the place of day. This prediction is complete with respect to the phenomena and to everything connected with it which can influence the material interest of mankind, yet it is entirely independent of the question, What causes the moon to gravitate toward the earth and sun? It is founded on certain laws of the motion of the moon; but in investigating those laws the questions why the moon gravitates toward the earth and sun; whether she moves by virtue of the immediate will of the Deity, or of some quality inherent in the matter of which she is composed; and whether such a quality was impressed upon her matter by the Deity, or is self-existent in the matter itself, — are entirely ignored. It is by ignoring them, and confining the attention to the purely phenomenal aspect of the problem, that the laws in question have been discovered.

The antithetical proposition is, that, as an almost or quite universal rule, scientific discoveries are never made by men having any practical object in view. To take a single instance among the long series of discoveries in electricity which finally made the telegraph possible, not one was made with any other object than the increase of knowledge of natural laws; and no practical telegrapher was ever known to discover a new law of electricity. The same remark applies to all those scientific discoveries which have made modern society what it is. It

seems as if Nature persistently refuses the knowledge of her secrets to those who seek them from any other motive than the love of truth. In this case, as in many others, the highest utility is most effectually reached by not seeking utility at all. Nothing is more certain than that, if we are to make any further advance in our knowledge of nature, it must be through the labors of men who make the study of nature the principal business of their lives, and who are trained accordingly.

At the same time, such men must have some inducement for entering upon this field of labor. The question may here arise, whether the claim that any worldly inducement will really lead to successful scientific investigation is not invalidated by the very principle just laid down. If knowledge must be sought for its own sake, how can we be asked to hold out other rewards for seeking it? If men will not pursue it without such reward, will they really pursue it successfully under the influence of the reward?

It might be a sufficient reply to these questions to say, that the simple acquisition of knowledge by investigators is not sufficient; the knowledge acquired must be published to the world before it can be of any value to others. Now, investigating and publishing are two very different things. The latter requires the work to be put into such a form that it can pass the closest criticism. One may study Nature most industriously for her own sake, and yet refuse to read proof-sheets, without a strong inducement of a much lower order. It is in the quantity of published matter that the deficiencies we have pointed out are seen. If esoteric science were of any public importance, we might find a great deal of it in this country. The difficulty is, not that our scientific men are indifferent to knowledge, but that they do not go through the laborious and thankless process of digesting and elaborating their knowledge and publishing it to the world.

There is yet another aspect of the case. While the motives which may induce one to spend one's life in a particular line of activity seldom admit of accurate analysis and definition, there are two propositions which cover the ground now under discussion. Let us admit that pursuing knowledge with no higher object than the applause of mankind, or the acquisition

of wealth, will never lead to any result. It must also be admitted that to assert that the good opinion of his fellow-men should not be a motive to exertion, is simply saying that one should be entirely indifferent to that opinion, — a proposition which none will directly maintain. And however derogatory to science it may be to pursue it with a view to wealth, no one will directly maintain that scientists as a class should be above supporting their families and paying their debts. The distinction between love of notoriety and honorable ambition, and between the love of wealth and the desire to pay one's way in the world, is too obvious to make it necessary for us to draw it here.

Let us now consider more closely the relative inducements to scientific research here and in Europe, and see whether they are not nearly or quite sufficient to account for the backwardness of research here. In Germany the seats of scientific activity are the universities; in France and England, the learned societies. We have, therefore, to compare our universities and learned societies with those of England and the Continent. When we examine the universities of Germany, and compare them with our own, one of the most obvious points of contrast is that, while here the universities make the professors, there it is the professors who make the university. Students flock to Berlin, not because the university is an old, celebrated, and good one, but to hear Helmholtz and Virchow. If all the men like these should leave the university, the students would follow them, and the university would at once sink to the second or third rank. But in this country students are not attracted to Harvard and Yale by the names of individual professors, but by the reputation and organization of the colleges. They choose one or other of these institutions because they know that a certain system of instruction has been organized, and that certain facilities are afforded by which they can be well instructed. If the professor is a good teacher, they demand nothing further of him.

This is by no means a simple difference of organization between the universities of the two countries, but a difference arising out of a fundamental peculiarity of the German mind, namely, a desire to be taught by a great man. In the Ameri-

can student we can hardly see any evidence of the existence of this trait. But in the German it is most strongly marked, and to it, combined with that love of thoroughness, and that wholesome contempt of "rule of thumb" systems which in this country pass as "practical," is largely due, not only German pre-eminence in every branch of intellectual activity, but very largely the present position of the German nation.

It is quite possible that the difference of which we speak would be found, on analysis, to be not so much a difference in the amount of respect entertained for intellectual greatness as in the standard of greatness. It is quite likely that, on the whole, the genus Professor is held in as high respect here as in Europe. But here the respect is called forth by the title, the position, and the learning, without which it is supposed the position could not have been gained, while in Germany it is dependent on what the professor adds to knowledge. The simple knowledge of what others have done in any special branch of research commands no more respect there than here, but probably a great deal less. Whether in the departments of science, philosophy, or the humanities, the question is, not what does he know, but what has he discovered that is new. What doubts has he cleared up? What fallacies has he exposed? What increase of precision has he given to the subject he has studied? The professor for whom satisfactory answers to these questions cannot be given, who is unknown as an investigator or thinker, and who can impart to his hearers no ideas but such as he has acquired from others, loses caste, gradually perhaps, but as certainly as, in mercantile life, the merchant who does not study the course of the market loses wealth. His students drop off, and, if his fellow-professors are like him, nothing will prevent his university from rapidly sinking to a low grade.

On the other hand, the man who has made really important additions to knowledge, and who has something fresh to make known to his hearers, needs neither the title nor position of professor to secure himself an appreciative and paying audience, and an honorable standing at the university. The humblest *Privat-docent* can compete with the oldest professor, certain that his future success will not depend on the favor of a

board, or on any system of promotion by seniority, but on his real merit as an advancer and expounder of knowledge. Under this system there are no favors to deserving young men as such, and no positions for men who have failed to make a living in other spheres of activity. Instead of these, we have the same fierce struggle for existence which is at the root of human development, and which has full play in most of the affairs of men,—a struggle in which the weak are pushed to the wall without mercy, and prizes are gained in proportion to strength.

In striking contrast to this system is that which we find to prevail here. Among the large number of our so-called universities, in fact at all outside of the Eastern States, nothing more is expected of a professor than acquaintance with a certain defined curriculum, and ability to carry the student through it. He has nothing to do but satisfy the appointing power that he understands what is found in a certain text-book, and that he can teach what he knows to others. Even at our highest institutions of learning, Harvard and Yale for instance, we find nothing like the German standard. However great the knowledge of the subject which may be expected in a professor, he is not for a moment expected to be an original investigator, and the labor of becoming such, so far as his professional position is concerned, is entirely gratuitous. He may thereby add to his reputation in the world, but will scarcely gain a dollar or a hearer at the university.

If the immediate necessity of originality is so much greater on the part of a German professor, so, in a certain way, is the reward of entire success. We do not refer mainly to a pecuniary reward, but if we did, the proposition would be partly true, and the state of things would forcibly illustrate the difference of the two systems which we are trying to bring out. We have said that probably the genus Professor is held in as high estimation here as in Germany. We may add, that the average professional income is much higher here, even when we make allowance for the greater cost of the necessities of life. But there the greater part of the income is earned by being a great man and a great expounder, and there being no definite limit to what may thus be gained, the highest incomes, and, consequently, the pecuniary rewards held out for becoming a first-

class man, are higher than any which a board of trustees can vote in this country. Of course the third and fourth rate men are much worse off than here; so much worse off, in fact, that they are compelled to betake themselves to some other occupation for a livelihood. The reward to which we principally refer is, however, that of reputation and esteem. The successful German professor, as he grows old, secures a position in the affections of a large body of educated men corresponding to which we have nothing at all to show, at least in the case of one who is merely an investigator and teacher. If one wishes to fully realize this, he need only witness the *Jubiläum* of any eminent German professor or scientist, and see the congratulations showered upon him by individuals and organizations from every part of the country, and then try to remember when he ever heard of any one taking any notice of an American professor becoming an "Emeritus," or even giving the occasion more than a passing thought.

When we pass from Germany to England, we find the state of things entirely different. The love of being taught by a great man, to which we have traced some of the peculiarities of German universities, is as completely unknown in England as here, and, in respect to the features we have been describing, the English university is much more like the American than like the German. If, therefore, the English investigator depended on the universities for support and encouragement, we should expect to find scientific investigation as backward in England as here. But the part which is played by the educational system of Germany is in England played by the great scientific societies. The general organization of these societies is substantially the same as in this country. On the European Continent each considerable nation has its Academy of Sciences, either supported or patronized by the government. In England and America, however, it is considered no part of the functions of the government to support such a body; the scientific societies of these countries must therefore be supported by the contributions of their members and by private endowments. Now, it is a fact which we have to face, and which it would be folly to disguise, that our scientific societies do not compare with those of England in wealth and power. There are a score

or two of English societies which regularly publish transactions. The membership in the leading societies ranges from four hundred to a thousand, or even several thousand, while the annual contribution of each member is from two to four guineas. The annual income from the members alone may therefore range from four thousand to twenty thousand dollars, while the older societies have invested their surplus income from time to time in such amounts as to now receive a considerable annual interest.

Of the corresponding data for American societies we have no exact statistics available. We cannot, however, be seriously in error in saying that the Geographical Society of New York and the American Association for the Advancement of Science are the only bodies in the country, of which exact or physical science forms one of the objects, the paying membership in which amounts to two hundred. We believe also that the maximum annual contribution in any of our societies is five dollars, while in a great many it is much less. In the American Association it is only three dollars. The societies we have mentioned are probably the only ones of which the annual income from the contributions of their members amounts to a thousand dollars. So far as is known, it is only two or three of the older societies that have any other source of income than this. By this lack of wealth, not only are our societies deprived of the means of publishing papers, but they are deficient in one of the great elements of interest and strength. However out of place the love of wealth may be in such a body, it cannot be denied that every one will take much more interest in an organization in which he has a good deal of money invested than in one in which he has none.

The great weakness of most of our scientific organizations does not, however, consist in the want of financial means, but in something much more difficult to determine and define. We can only say that, with a few exceptions, they exhibit a total lack of cohesive power, vitality, and that undefinable something which may be called weight and importance. However eminent may be the men who compose them, most of them are, as organizations, insignificant, and exhibit the same liability to die from slight causes that weak and sickly individuals

do. A history of all the attempts to organize learned societies in this country would afford an instructive study in human nature, and might show that they died by causes as uniform as those which cause the decay and death of individuals. The principal features of the decadence would be, first, a constant enlargement of the range of membership, and consequent lowering of the tone of society; then a gradual and unnoticed falling off of the abler members, until the society is reduced to a state which a physician would describe as great constitutional weakness. This change may require a few months or many years. The society is then attacked by a parasite in the form of a charlatan desirous of using it as a means of securing a temporary notoriety for himself. He secures the management and control of it, and furnishes most of its discussions, till he makes it ridiculous, and then society and charlatan disappear together from public view.

If strength is relative, so that power in charlatanry is the same thing with weakness in integrity, then a curious instance of the weakness of real science is afforded by an attempt to organize a national scientific society a few years since. Many of our readers may remember "The American Union Academy of Literature, Science, and Art," organized in Washington in 1869. It had no known sponsor, unless the messenger who carried round a paper to get the signatures of prominent men should be considered such. But it soon began to fill a prominent place in the local papers. It had an opening meeting, and an inaugural address from a president. A few months later it had another inaugural address from another president. It got scientific questions referred to it by the Commissioner of Internal Revenue, and made reports on them. It applied to Congress for a charter recognizing it as a scientific adviser of the government; and an act of incorporation so recognizing it passed the House of Representatives without opposition, and was favorably reported from the proper committee of the Senate.

During all this time not a solitary man eminent in literature or science was known to be responsible for the society. The list of corporators named in the charter included judges, lawyers, bankers, officers of the army and navy, and a few civil

officers of the government of every grade, but only a single eminent scientist, and he resided in a distant State, and probably knew nothing of the real character and objects of the organization. In fact, it is not likely that the large majority of the corporators themselves knew anything more than that they had been asked to join a very modest association for the mutual improvement of its members by scientific discussions. Why such an association should want national recognition from Congress, no one ever explained.

As we have said, the charter was reported to the Senate from the Committee on the District of Columbia, with recommendation that it pass. But there happened to be a single senator who saw the absurdity of choosing such a set of corporators to report on scientific "questions of importance to the public interest, which may be officially submitted to the Academy or its branches by the officers of the general or State governments." This was Mr. Sumner. After a vigorous debate, in which, however, the provision we have just quoted was strangely overlooked, the bill was laid upon the table, and the society gradually sank into oblivion.

The most important function of the English societies is to take the place of the university system of Germany in encouraging scientific research. This they do by prompt publication of papers, by favorable notices of small works, and by the public award of prizes to great works. The details of the way in which this encouragement is given are, however, not important. The important fact which we wish to impress on the mind of the reader is, that when an Englishman makes any scientific investigation or discovery of merit and importance, he is considered a valuable member of society, and society takes pains publicly to indicate its appreciation of his value. When we say that in this country one may devote his life to science, and may gratuitously give to scientific investigation an amount of labor and talent which would secure him both wealth and distinction in any other profession, without receiving therefor a solitary public mark or expression of appreciation from any source whatever, or the slightest additional consideration from the public, hardly anything more is necessary to show that there is here comparatively little incentive

to such work. One fact connected with our governmental administration will illustrate the small amount of weight which the public assign to science. There are several government establishments of a scientific character, the best administration of which would require high scientific attainments, to the head of which scientific men would naturally be appointed if the public deemed them of sufficient importance. Yet not one of these establishments has now a head appointed on the score of eminence as an investigator in the sciences with which the operations of the establishment are allied, and there is probably not more than one of which the head could make pretensions to an acquaintance with any science whatever. This does not arise from those defects of the civil service of which the public now complain. If science carried with it here the same social and personal influence as abroad, the scientific clique would under our present system divide the scientific offices among its members just as the politicians do the political offices. They fail to do so, not because they are not politicians, but because they are weak.

The great drawback to American science which we have been considering is, not lack of facilities, but lack of incentive. In fields of research requiring good libraries, or expensive appliances in the way of instruments and apparatus, our facilities are, it is true, confined to the East. In other respects they are as good as in Europe, and in some points better. For one thing, it may be doubted whether any other government is as ready as our own to appropriate money for scientific objects. However contracted many of the views of the "average Congressman" may be, he has intelligence enough to know that the knowledge of nature forms an important element of our civilization, and is quite willing to afford the means of increasing that knowledge, on being satisfied that the money will be judiciously expended. It is not always easy to insure the fulfilment of the last condition under our present system, owing partly to the want of some permanent scientific body to which the expenditure of moneys for scientific objects might be intrusted, and which could be held responsible for its doings. This drawback has not generally proved a serious one, and we believe that scientific appropriations have been, without excep-

tion, honestly expended, if not always in the most judicious manner.

On the whole, we may say that if any one possessing the qualities of sound judgment, accurate thinking powers, and quick perception of the relations of cause and effect, chooses to devote them to the increase of knowledge, and to forego the worldly advantages they would secure for him in the ordinary fields of human activity, his opportunities will be as good here as elsewhere. But he must fight his way with the same persistence that he would in any other profession, with the probability that he will be a great deal longer in winning even the modest position which society here assigns to the eminent investigator. He can adopt another profession with the assurance of gaining employment, wealth, and position as fast as he can satisfy the public of his ability; while in scientific as in military life, age and seniority are still indispensable to any high recognition. In political life one may become representative in Congress, senator, chairman of a congressional committee, or even Cabinet officer, at an age when his youth would be considered a serious if not a fatal objection to the highest recognition of his scientific claims. Some well-known examples from the French Academy of Sciences, during the period when it was in the prime of its activity, and the leading scientific body of the world, will afford an instructive contrast to our system. To this day the Academy is reproached by its historians for its unpardonable neglect of the claims of young La Place, whom, notwithstanding the talent and activity displayed in his memoirs, it persisted in considering a neophyte long after he had proved himself a master; and La Place himself is complimented for not being discouraged by this neglect. Yet he was elected a member of the Academy when he was between twenty-eight and thirty years of age, — an age at which it would be an act of hardihood even to propose a candidate for membership to our National Academy of Sciences, no matter how high his claims.

In 1809, Poisson and Arago were candidates for the vacancy in the section of Astronomy caused by the death of La Lande. The former, though he had never made a distinctively astronomical investigation, was earnestly supported by La Place on the

score of age and position ; but Arago was elected by a large majority, in consideration of his work in the measurement of an arc of the meridian. Yet the man of age and position was only twenty-eight, and his successful competitor was only twenty-three. The former was not elected till he was thirty-one, when the Academy, no longer willing to sustain the reproach of overlooking so eminent a man, elected him to a vacancy in the section of Physics, although it was only as a mathematician that he had acquired eminence.

We do not propose to enter into any discussion of the relative merits of simple age and social position on the one hand, and talent and industry on the other. But it is undoubtedly true that the latter must be recognized in preference to the former, just in proportion to our earnestness in promoting works which can be performed only by talent and industry. For instance, in our military and naval service, in time of peace, promotion and command go strictly by seniority, — a system which has the advantage of avoiding every suspicion of favoritism, and saving the appointing power the responsibility of deciding between the merits of a large number of candidates. But in the selection of leaders in time of war, the system breaks down, and ability necessarily takes the place of seniority in determining the choice.

So in scientific affairs : by making scientific recognition the reward of age and personal influence rather than of talent and industry, we avoid a great deal of heartburning, bitterness, and strife. So far as the avoidance of these is an important end in society, so far is our system a good one. But it is none the less true that our country will never contribute its share to human knowledge under this system. Science forms no exception to that law of nature which proportions awards to merit and exertions, and gives the strong the advantage over the weak ; and no amount of sentiment will do away with the fact that it is to the operation of this law that the progress of the world is due.

What we have just said refers to the scientific recognition of the young man of science among his fellow-workers. But respect and reputation are awarded by the intelligent public as tardily as by scientific men. We refer, of course, to respect

for scientific work, not to that for the popularization of science. If our young man is a good popular writer and lecturer, he can hew his own way to fame with nearly as much rapidity in this as in any other country. But popular lecturing is something entirely different from scientific research, — so different that few succeed in both fields of activity ; and it is the worker in the latter field whom the public are prone to treat with indifference. If it is urged that reputation with the public is too low a motive to be set before a young man, we reply, that the very reason it is low is the comparative lowness of the means by which the end may be secured. Apart from this, it cannot be denied that a wide and solid reputation among educated and influential men is a valuable thing to any one ; and the more rapidly a young man can obtain it in any pursuit, the more encouragement he has to enter upon that pursuit. If such a reputation in the scientific line can be more readily obtained by showy works than by those which are really solid and valuable, the remedy is, not to treat it with contempt, but to educate that small portion of the public whose good opinion is of any moment into an appreciation of the real state of things.

Now, our instrumentalities for communicating to the educated public a knowledge of the doings of the scientific world have, until very lately, been nearly as defective as our means of scientific publication, and, notwithstanding certain recent improvements, are still far behind those of other nations. In England, France, and Germany weekly, monthly, and quarterly journals of popular science are too numerous to be recounted ; while, previous to the establishment of the “ Popular Science Monthly ” by the Appletons, we had not in this country a single journal designed to diffuse the knowledge either of general or exact science. The “ American Naturalist,” as its name implies, is devoted entirely to biology. One of our principal scientific wants has been a publication which should serve as a medium of communication between scientific men and the educated public as well as between the various classes of scientific workers. To fulfil the latter object it need not be too technical for the former object, for a specialist in one branch may know as little about the work of a specialist in another branch as the general public does. A geological theory, for

instance, must be explained to an astronomer just as it would be explained to any other intelligent reader, and *vice versa*.

In the absence of any such publication, nearly all the scientific information attainable by the public has been derived directly or indirectly from English sources, generally from the proceedings of the English scientific societies. The latter, being organized for the promotion and encouragement of the science of their own country, naturally give prominence to the labors of their own members; and we may say that English scientific writers generally adopt the same system. The consequence is, that in acquiring an American reputation the American stands at the same disadvantage alongside the Englishman that he does in acquiring an English reputation. Another cause conspires to make his disadvantage really greater, namely, the general incredulity respecting the possibility of native talent which seems to be inherent in the American mind. The result of both causes combined is, that an American must obtain a European reputation before his own countrymen begin to believe in him.

Of course there are exceptions to this rule. One occupying so high an official position that he must be treated with respect, and taking care to keep himself prominently before the public, may secure even more public consideration than he is entitled to. But neither the holding of office nor public prominence constitutes scientific position, so that it is doubtful whether even this should be considered an exception. The main fact with which we have to deal is, that original scientific research does not by itself command the public consideration which the same talent would if directed in other ways, nor which it would if exercised in the same way by a European. The proposition that an original investigator can receive consideration in his own country only after acquiring a European reputation, is not invalidated by showing that if he be something else than an investigator the proposition will not apply.

Within the past three or four years there has been a large increase in the amount of popular scientific publication in this country, which is seen in the establishment of a scientific magazine, and in the appearance of "scientific columns" and "scientific departments" in many of our newspapers and

magazines. But the great object of educating the intelligent public in scientific matters is very imperfectly fulfilled by these publications. A considerable portion of the matter they present to us consists of fugitive items, hardly more interesting or important than the column of daily clippings of one short sentence each which has become a feature of our newspapers. The most notable exceptions have been the science department of the "Atlantic Monthly," while it lasted; the Editors' Table of the "Popular Science Monthly"; and, of late, the Science Record of "Harper's Magazine." Here we have found original discussions of scientific questions, and reviews of the progress of science by competent writers. For the rest of the "Popular Science Monthly" so much cannot be said. When first started it was mostly made up of extracts from English publications and of essays which could hardly have found a place in any other publication. Of late it has gradually improved by including more original matter, and that of a better class. But it has never attempted to supply the great want to which we have referred, namely, that of making known the progress of science in this country; and the reader who wishes to learn what our scientific men are doing here will find far more copious accounts of it in "Nature," an English periodical, than he will in the American magazine referred to.

The various deficiencies in the incentives to scientific research which we have described may be summed up in the single proposition, that the American public has no adequate appreciation of the superiority of original research to simple knowledge. It is too prone to look upon great intellectual efforts as mere *tours de force*, worthy of more admiration than the feats of the gymnast, but not half so amusing, and no more in need of public support. The remedy is to educate the intelligent public into an appreciation of the importance of scientific investigation, and of the necessity of bestowing upon those who are successfully engaged in it something in the way of consideration which may partially compensate them for devoting their energies to tasks which, from their very nature, can bring them no pecuniary compensation. This reward must be proportioned to merit, and the absence of commanding personal qualities must not be an obstacle to obtaining it. A great man can just

as well be produced here as in Europe, if the public will only become disposed to encourage intellectual greatness here as there. If we had an equally rigorous system of intellectual natural selection and equal public encouragement for talent of the highest class, America would rapidly take a leading position among the scientific nations of the world.

SIMON NEWCOMB.

ART. III. — *The Sources of Standard English.* By T. L. KINGTON OLIPHANT, M. A., of Balliol College, Oxford. London. 1873.

THAT, except on paper, the project of a philosophical language will ever be realized, no one, in our day, can believe seriously. And yet it may be, that, before the lapse of another millennium, from the influence of conspiring causes, already in vigorous action, the world may behold what would serve mankind much better than any philosophical language, namely, an approach to a universal language. We can, indeed, hardly suppose the entire obliteration of local varieties of oral speech; but the time may, quite possibly, be not very remote, when the languages now used by the leading civilized peoples shall so far possess, in their written form, a common element, as to become materially assimilated. Nor, should such a consummation ever be reached, can we hesitate to forecast as to its principal agents, provided it be not in the lot of Englishmen and Americans to decline, in a marked degree, from that character of energy which has so long distinguished them, and which, it would appear, the ages have not yet even fully ripened. Only a hundred years ago, and where did English prevail, save in its birthplace and among the American colonies? Its dominions at this moment we need not stop to enumerate. And it is by no means to the mere numerical preponderance of English-speaking populations that its spread is, in all cases, attributable. Conquest, commerce, and convenience have largely contributed to extend its diffusion. In India, with